Designation: D 3665 – 99

Standard Practice for Random Sampling of Construction Materials[1]

This standard is issued under the fixed designation D 3665; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the determination of random locations (or timing) at which samples of construction materials can be taken. For the exact physical procedures for securing the sample, such as a description of the sampling tool, the number of increments needed for a sample, or the size of the sample, reference should be made to the appropriate standard method. The selection procedures in Section 4 utilize the table of three-digit numbers given in Table 1.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 172 Practice for Sampling Freshly Mixed Concrete[2]

C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement[3]

D 75 Practice for Sampling Aggregates[4]

D 140 Practice for Sampling Bituminous Materials[4]

D 345 Test Method for Sampling and Testing Calcium Chloride for Roads and Structural Applications[4]

D 979 Practice for Sampling Bituminous Paving Mixtures[4]

D 5361 Practice for Sampling Compacted Bituminous Mixtures for Laboratory Testing[4]

E 105 Practice for Probability Sampling of Materials[5]

E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality for a Lot or Process[5]

E 141 Practice for Acceptance of Evidence Based on the Results of Probability Sampling[5]

3. Significance and Use

3.1 This practice is useful for determining the location or time, or both, to take a sample in order to eliminate any intentional or minimize any unintentional bias on the part of the person taking the sample.

NOTE 1—The effectiveness of this practice in achieving random samples is limited only by the conscientiousness of the user in following the stipulated procedures.

3.2 A less detailed procedure is included in 5.8 for normal usage and is considered the most practical means except where the sampling is deemed extremely critical or where dispute is anticipated.

3.3 The selection procedures and examples in this standard provide a practical approach for ensuring that construction material samples are obtained in a random manner. Additional details concerning the number of sample increments, the number of samples, the quantities of material in each, and the procedures for extracting sample increments or samples from the construction lot or process are contained in Practices C 172, C 183, D 75, D 140, D 979, D 5361, and Test Method D 345.

3.4 This standard contains examples citing road and paving materials. The concepts outlined therein are applicable to the random sampling of any construction material and can easily be adapted thereto.

3.5 Additional sampling guidance is provided in Practice E 105 concerning probability sampling, Practice E 122 concerning choosing sample sizes to estimate the average quality of a lot or process (see Note 2), and in Practice E 141 for acceptance of evidence based on results of probability sampling.

NOTE 2—The guidance contained in Practice E 122 is not available in other documents referenced in this section.

3.6 The best and most practical method for ensuring that samples of construction materials include the full range of a construction process is by incorporating a stratified-random sampling procedure into the sampling process. To implement a stratified-random sampling procedure, divide the lot to be sampled into the desired number of equal sublots and randomly sample each sublot in accordance with this standard.

NOTE 3—If the sublots are of unequal size, it will likely be necessary to weight the samples in order to maintain a fair and defensible sampling process.

4. Selection Procedures

4.1 *Sampling from a Belt or Flowing Stream of Material*:

4.1.1 Determine the length of time, *t*, in minutes, for the lot of material to be sampled to pass the sampling point and determine the number of samples, *n*, to be taken from the lot.

[1] This practice is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.30 on Methods of Sampling.

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[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.01.

[4] *Annual Book of ASTM Standards*, Vol 04.03.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

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TABLE 1 Table of Random Numbers

	0	1	2	3	4	5	6	7	8	9
1	0.272	0.519	0.098	0.459	1.000	0.554	0.250	0.246	0.736	0.432
2	0.994	0.978	0.693	0.593	0.690	0.028	0.831	0.319	0.073	0.268
3	0.039	0.449	0.737	0.501	0.960	0.254	0.239	0.474	0.031	0.720
4	0.144	0.695	0.339	0.621	0.128	0.032	0.413	0.617	0.764	0.257
5	0.312	0.138	0.670	0.894	0.682	0.061	0.832	0.765	0.226	0.745
6	0.871	0.838	0.595	0.576	0.096	0.581	0.245	0.786	0.412	0.867
7	0.783	0.874	0.795	0.430	0.265	0.059	0.260	0.563	0.632	0.394
8	0.358	0.424	0.684	0.074	0.109	0.345	0.618	0.176	0.352	0.748
9	0.494	0.839	0.337	0.325	0.699	0.083	0.043	0.809	0.981	0.499
10	0.642	0.514	0.297	0.869	0.744	0.824	0.524	0.656	0.608	0.408
11	0.485	0.240	0.292	0.335	0.088	0.589	0.127	0.396	0.401	0.407
12	0.728	0.819	0.557	0.050	0.152	0.816	0.404	0.079	0.703	0.493
13	0.029	0.262	0.558	0.159	0.767	0.175	0.979	0.521	0.781	0.843
14	0.918	0.348	0.311	0.232	0.797	0.921	0.995	0.225	0.397	0.356
15	0.641	0.013	0.780	0.478	0.529	0.520	0.093	0.426	0.323	0.504
16	0.208	0.468	0.045	0.798	0.065	0.315	0.318	0.742	0.597	0.080
17	0.346	0.429	0.537	0.469	0.697	0.124	0.541	0.525	0.281	0.962
18	0.900	0.206	0.539	0.308	0.480	0.293	0.448	0.010	0.836	0.233
19	0.228	0.369	0.513	0.762	0.952	0.856	0.574	0.158	0.689	0.579
20	0.746	0.170	0.974	0.306	0.145	0.139	0.417	0.195	0.338	0.901
21	0.363	0.103	0.931	0.389	0.199	0.488	0.915	0.067	0.878	0.640
22	0.663	0.942	0.278	0.785	0.638	0.002	0.989	0.462	0.927	0.186
23	0.545	0.185	0.054	0.198	0.717	0.247	0.913	0.975	0.555	0.559
24	0.360	0.349	0.569	0.910	0.420	0.492	0.947	0.115	0.884	0.452
25	0.789	0.815	0.464	0.484	0.020	0.007	0.547	0.941	0.365	0.261
26	0.279	0.609	0.086	0.852	0.890	0.108	0.076	0.089	0.662	0.607
27	0.680	0.235	0.706	0.827	0.572	0.769	0.310	0.036	0.329	0.477
28	0.078	0.444	0.178	0.651	0.423	0.672	0.517	0.660	0.657	0.972
29	0.676	0.830	0.531	0.888	0.305	0.421	0.307	0.502	0.112	0.808
30	0.861	0.899	0.643	0.771	0.037	0.241	0.582	0.578	0.634	0.077
31	0.111	0.364	0.970	0.669	0.548	0.687	0.639	0.510	0.105	0.549
32	0.289	0.857	0.948	0.980	0.132	0.094	0.298	0.870	0.309	0.441
33	0.961	0.893	0.392	0.377	0.864	0.472	0.009	0.946	0.766	0.287
34	0.637	0.986	0.753	0.566	0.213	0.807	0.017	0.460	0.515	0.630
35	0.834	0.121	0.255	0.453	0.376	0.583	0.422	0.371	0.399	0.366
36	0.284	0.490	0.402	0.151	0.044	0.436	0.747	0.694	0.136	0.585
37	0.038	0.814	0.594	0.911	0.324	0.322	0.895	0.411	0.160	0.367
38	0.351	0.283	0.027	0.220	0.685	0.527	0.943	0.556	0.853	0.612
39	0.143	0.384	0.645	0.479	0.489	0.052	0.187	0.990	0.912	0.750
40	0.512	0.056	0.018	0.122	0.303	0.803	0.553	0.729	0.205	0.925
41	0.296	0.705	0.156	0.616	0.534	0.168	0.564	0.866	0.739	0.850
42	0.451	0.536	0.768	0.518	0.481	0.880	0.835	0.734	0.427	0.847
43	0.837	0.405	0.591	0.370	0.104	0.848	0.004	0.414	0.354	0.707
44	0.724	0.153	0.841	0.829	0.470	0.391	0.388	0.163	0.817	0.790
45	0.665	0.825	0.671	0.623	0.770	0.400	0.068	0.440	0.019	0.944
46	0.573	0.716	0.266	0.456	0.434	0.467	0.603	0.169	0.721	0.779
47	0.332	0.702	0.300	0.570	0.945	0.968	0.649	0.097	0.118	0.242
48	0.755	0.951	0.937	0.550	0.879	0.162	0.791	0.810	0.625	0.674
49	0.439	0.491	0.855	0.446	0.773	0.542	0.416	0.350	0.957	0.419
50	0.700	0.877	0.442	0.286	0.526	0.071	0.154	0.988	0.333	0.626

Following the instructions accompanying Table 1, pick *n* numbers to determine the times *t* to select the necessary samples.

4.1.2 *Example*:

4.1.2.1 The lot of material to be sampled from a flowing stream at a transfer point is defined as 480 min of production. Five samples are required from the lot. From Table 1, the following five numbers were picked:

0.091
0.420
0.217
0.370
0.006

These numbers are used directly (decimals disregarded) to determine the sample selection times. Any number over 480 should be discarded and another chosen.

4.1.2.2 Thus, samples will be taken at the following times

TABLE 1 *Continued*

	0	1	2	3	4	5	6	7	8	9
51	0.523	0.613	0.752	0.733	0.528	0.072	0.820	0.929	0.777	0.461
52	0.905	0.182	0.567	0.249	0.227	0.229	0.604	0.304	0.217	0.142
53	0.373	0.120	0.602	0.793	0.692	0.863	0.954	0.873	0.107	0.675
54	0.057	0.953	0.041	0.090	0.223	0.508	0.806	0.438	0.203	0.586
55	0.967	0.040	0.708	0.271	0.189	0.342	0.740	0.801	0.985	0.263
56	0.917	0.715	0.758	0.005	0.666	0.599	0.934	0.100	0.987	0.085
57	0.131	0.646	0.659	0.047	0.051	0.562	0.435	0.731	0.362	0.317
58	0.326	0.605	0.443	0.601	0.386	0.560	0.378	0.172	0.445	0.636
59	0.299	0.106	0.237	0.732	0.796	0.476	0.099	0.804	0.735	0.950
60	0.101	0.055	0.776	0.686	0.171	0.533	0.936	0.095	0.982	0.211
61	0.267	0.598	0.754	0.658	0.274	0.215	0.177	0.218	0.330	0.628
62	0.471	0.102	0.454	0.568	0.963	0.357	0.882	0.507	0.157	0.580
63	0.535	0.881	0.014	0.966	0.958	0.190	0.180	0.759	0.433	0.355
64	0.277	0.458	0.295	0.196	0.772	0.148	0.466	0.291	0.688	0.046
65	0.719	0.167	0.181	0.653	0.328	0.070	0.015	0.155	0.631	0.063
66	0.385	0.858	0.713	0.883	0.916	0.084	0.561	0.999	0.379	0.668
67	0.862	0.928	0.822	0.812	0.977	0.395	0.788	0.920	0.673	0.698
68	0.486	0.938	0.757	0.749	0.991	0.219	0.264	0.932	0.898	0.006
69	0.091	0.872	0.959	0.922	0.727	0.811	0.075	0.374	0.133	0.730
70	0.146	0.482	0.930	0.611	0.179	0.011	0.248	0.886	0.344	0.926
71	0.709	0.184	0.390	0.409	0.191	0.117	0.860	0.135	0.406	0.134
72	0.996	0.896	0.760	0.347	0.053	0.372	0.193	0.756	0.565	0.914
73	0.971	0.859	0.147	0.114	0.418	0.889	0.792	0.064	0.652	0.288
74	0.202	0.538	0.026	0.949	0.696	0.008	0.846	0.259	0.415	0.425
75	0.212	0.321	0.778	0.940	0.496	0.231	0.664	0.903	0.473	0.909
76	0.207	0.799	0.487	0.022	0.813	0.891	0.500	0.368	0.725	0.437
77	0.818	0.503	0.906	0.224	0.904	0.892	0.455	0.343	0.924	0.197
78	0.701	0.984	0.174	0.141	0.704	0.908	0.048	0.828	0.997	0.058
79	0.035	0.380	0.001	0.381	0.251	0.497	0.214	0.794	0.552	0.588
80	0.221	0.200	0.587	0.353	0.584	0.270	0.885	0.110	0.956	0.711
81	0.647	0.403	0.530	0.738	0.280	0.457	0.650	0.276	0.661	0.973
82	0.667	0.722	0.327	0.723	0.410	0.635	0.012	0.907	0.316	0.677
83	0.644	0.590	0.021	0.269	0.042	0.062	0.387	0.183	0.964	0.544
84	0.302	0.123	0.116	0.282	0.851	0.256	0.648	0.845	0.782	0.993
85	0.633	0.933	0.331	0.546	0.842	0.016	0.236	0.164	0.923	0.976
86	0.060	0.681	0.683	0.775	0.624	0.955	0.126	0.655	0.919	0.113
87	0.165	0.532	0.431	0.341	0.092	0.244	0.222	0.336	0.034	0.216
88	0.875	0.691	0.383	0.382	0.596	0.301	0.275	0.188	0.868	0.805
89	0.726	0.902	0.252	0.130	0.238	0.398	0.763	0.463	0.615	0.140
90	0.273	0.393	0.285	0.161	0.619	0.865	0.551	0.030	0.571	0.258
91	0.253	0.821	0.600	0.023	0.606	0.849	0.610	0.577	0.082	0.774
92	0.340	0.654	0.173	0.495	0.498	0.992	0.192	0.506	0.751	0.129
93	0.194	0.290	0.592	0.983	0.509	0.998	0.522	0.627	0.741	0.540
94	0.166	0.450	0.210	0.204	0.840	0.826	0.833	0.516	0.965	0.375
95	0.712	0.314	0.033	0.823	0.629	0.939	0.887	0.066	0.743	0.081
96	0.622	0.800	0.710	0.575	0.678	0.465	0.802	0.969	0.150	0.784
97	0.313	0.294	0.897	0.718	0.614	0.876	0.025	0.049	0.620	0.125
98	0.137	0.087	0.003	0.483	0.201	0.209	0.320	0.935	0.447	0.787
99	0.243	0.679	0.844	0.069	0.024	0.543	0.714	0.234	0.505	0.428
100	0.361	0.359	0.230	0.761	0.334	0.149	0.511	0.475	0.854	0.119

after production begins (to the nearest 1 min and arranged in chronological order):

min
6
91
217
370
420

NOTE 4—The user may wish to decide a minimum time to allow the plant to become fully operational. In cases where the picked number results in a time less than this, the user should discard the picked number and choose another.

NOTE 5—While the above exact times were picked, in practice, the user may wish to round off actual sampling times to the nearest 5 min.

4.2 *Sampling From a Windrow of Material*:

4.2.1 Determine the total length of one windrow in metres that represents a lot of material and determine the number of samples, *n*, to be taken from the lot. Following the instruction accompanying Table 1, pick *n* numbers to determine the length, (*l*), from the start of the windrow from which samples will be taken.

4.2.2 *Example*:

4.2.2.1 A lot of material has been placed in windrows 900 m in length. It is desired to secure three samples from this lot. From Table 1 the following three numbers are picked:

0.526
0.704
0.193

4.2.2.2 These numbers are then multiplied by 900 giving the number of metres from the beginning of the windrow at which to sample. Thus, samples (rounded to the nearest metre and arranged in sequence) are selected at the following intervals:

174 m (900 × 0.193)
473 m (900 × 0.526)
634 m (900 × 0.704)

4.3 *Sampling In-Place Paving Material*:

4.3.1 Determine the length of one pavement representing a lot of material, the width of the pavement, *w*, and the number of samples needed for each lot, *n*. Following the instructions accompanying Table 1, pick *l* numbers corresponding to the length of pavement, followed by picking *w* numbers for width determination.

4.3.2 *Example*:

4.3.2.1 A lot is defined as 1.6 km of in-place 3.6-m wide pavement. Two samples are to be taken from each lot. Since there are 1600 m in the lot, enter the table and pick two numbers, which are then multiplied by 1600 m. In this instance, the two numbers chosen were:

0.376
0.529

4.3.2.2 Thus, the two samples will be taken at 602 and 846 m from the beginning of the pavement.

4.3.2.3 Determine the location from the edge of the pavement by selecting two additional numbers from Table 1, which are then multiplied by 3.6. In this case, the two numbers chosen were:

0.512
0.708

4.3.2.4 Therefore, the first sample should be taken 602 m from the beginning of the pavement (see 4.3.2.2) and 1.8 m from the designated (right or left) edge of the pavement.

4.3.2.5 The second sample should be taken 846 and 2.5 m from the designated (right or left) edge of the pavement.

4.4 *Sampling From a Loaded Truck*:

4.4.1 Determine the number of truck loads that represent a lot of material and determine the number of samples, *n*, needed from each lot. To determine which trucks to sample, pick *n* numbers from Table 1 and multiply these numbers by the number of trucks in the lot. To determine the quadrant in each truck to be sampled, choose *n* numbers from Table 1 and multiply by 4. Select the quadrant in accordance with the following criterea. Quadrant locations of the truck are numbered as shown in Fig. 1.

Calculated Random Number, N	Quadrant
$N \leq 1.0$	1
$1.0 < N \leq 2.0$	2
$2.0 < N \leq 3.0$	3
$3.0 < N \leq 4.0$	4

4.4.2 *Example*:

4.4.2.1 Twenty trucks are considered a lot and three samples are required. Using Table 1, the following three numbers were picked:

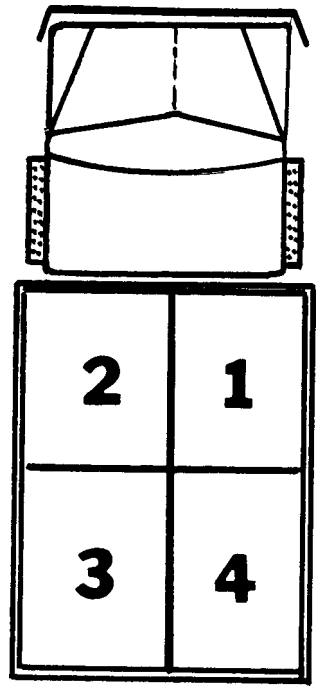

FIG. 1 Quadrants for Random Sampling from a Loaded Truck

0.251
0.424
0.865

4.4.2.2 Thus, trucks numbered 5 (0.251 × 20), 8 (0.424 × 20), and 17 (0.865 × 20) should be sampled.

4.4.2.3 To determine the quadrant locations, the following numbers were picked:

0.110
0.380
0.064

These are multiplied by 4 with the following results:

Quadrant 1 from truck No. 5 (4 × 0.110)
Quadrant 2 from truck No. 8 (4 × 0.380)
Quadrant 1 from truck No. 17 (4 × 0.064)

5. Instructions for Using the Three-Digit Table of Numbers (Table 1)

5.1 Table 1 consists of all numbers from 0.001 to 1.000. Each number appears only once.

5.2 Electronic calculators or random number generators can be used to select rows and columns. If pointers are used, to use Table 1 correctly and to eliminate bias, copy Table 1 from the book and place the two pages on a flat surface next to each other, point without looking to a number in the table. It may be advantageous to use a pointer such as a mechanical pencil with the lead retracted, the tip of a letter opener, or other pointed device.

5.3 After picking a number, the basis is established for locating the sought-after number in a more random, unbiased method.

5.4 Examine the first two digits of the three-digit number chosen. This number locates the line number (the vertical column on the left) to be used in finding the sought-after number.

NOTE 6—The digits 0.001 to 0.009 are invalid for choosing the line number. The number 1.000 is used for line number 100.

5.5 Once the line number is chosen, repeat the procedure in 5.2 and, using the first digit, pick the column number (the horizontal numbers at the top of the table).

5.6 The intersection of the results from 5.4 and 5.5 is the sought-after number.

5.7 The procedure, to be unbiased, must be followed as detailed in the foregoing or by some other locally devised method by which the user has no control over the numbers chosen. The table must be entered separately for any and all numbers selected. Repeat the selection procedure if an unusable number results.

5.8 Two alternative methods are described in 5.8.1 and 5.8.2. They are not considered as correct theoretically as the procedure described in 5.2 through 5.7; however, except in cases of dispute, they are considered to be acceptable alternatives for normal usage.

5.8.1 *Alternative 1*— Enter the table as described in 5.2, deciding beforehand that the required number of digits will be selected by moving up, down, right, or left from the number picked. Discard unusable numbers, and continue to the next number in the same direction. Decide beforehand what action to take when a number on the periphery of the table is reached and additional selections are needed.

5.8.2 *Alternative 2*— The user decides beforehand to begin in the top left corner (or top center, or bottom right, etc.) and move right and down (or left and up) picking the number of required usable numbers. Other variances might be: moving in the preplanned direction, picking every other number, or every third number, etc. Exercise care in using this method, giving numbers in the middle of the table an equal chance of being selected for any given time period.

6. Keywords

6.1 random number tables; sampling, random

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